sound-waves, photometry, plane mirrors, converging lenses, lines of magnetic force, construction of galvanic cells, action of electrical currents upon magnets, electrical resistance of wires, battery resistance, construction of electro-magnets. Nearly all of these exercises are of a quantitative character, requiring measurements of some kind. It is expected that they will be liberally supplemented with other less formal experiments, not necessarily to be performed by the student, such as are described in ordinary text-books, with problems, and with general teaching, all of such a range and character as to give effect and continuity to the course.

In considering whether such a course of physics is practicable there are several points to be looked at: —

1st. The material equipment required. It will not in general be practicable for a teacher to give proper attention to more than twelve students working in the laboratory at the same time. The cost of the *portable* apparatus and material needed to enable twelve students to follow the course marked out in this pamphlet, each working upon the same experiment at the same time but in general independently, may be any thing from $250 to $450, according to the amount of time and skill the teacher can devote to its preparation. I think this part of the equipment, with apparatus ready made, can be bought outright for the larger sum mentioned. There will be needed also two strong tables, each about twelve feet long and three feet wide, one or two sinks with water-faucets, and for each student a supply of gas for a Bunsen burner.

For a school already well supplied with the ordinary *illustrative* apparatus, the total cost of adding the material equipment for the laboratory course, on the scale supposed, may range from $400 to $800. If only one or two students are to be provided for, the cost may be not more than $50 or $100.

2d. The demand upon the pupil's time. In the summer of 1886, Harvard sent out to a large number of teachers of physics in preparatory schools a circular requesting answers to certain questions, one of which related to the amount of time devoted to this study in their respective schools. About eighty replies to this circular were received, and the conclusion from these replies was, that, in laying out the elementary physics courses for admission to the college, we might assume that the pupil would have for this subject the equivalent of one school exercise of about forty-five minutes daily for one school-year of thirty-five or forty weeks, with some hours of study weekly out of the school-room. The proposed course has been planned in accordance with this estimate. This is probably about as much time as will be required for elementary French or elementary German in fitting for Harvard, and not more than one-half as much as most candidates have given to prescribed Greek, or one-third as much as they have given to prescribed Latin.

3d. The arrangement of hours. Experience in the Harvard physical laboratory, with a course very similar to the one proposed for the schools, dictates the suggestions, 1, that one school-hour per week be given to a preliminary explanation, and perhaps hasty performance by the teacher, of the exercises presently to be undertaken by the pupils, the whole class being assembled for this exercise; 2, that each pupil have two consecutive school-hours per week for the actual performance of the formal experiments of the course, the class, if large, being divided for this purpose into sections of not more than twelve; 3, that the other two school-hours per week be devoted to the supplementary work of the course with the whole class assembled. In order that the time alloted for the laboratory work may be sufficient, the student should be required to plan his work and his note-taking, so far as this is practicable, before coming to the laboratory.

4th. The demand upon the teacher's time. Scholars so young as those will be who may take this course need much direction in their laboratory work. The teacher should be in the laboratory whenever work is going on there. The preparation and care of apparatus and the proper supervision of the students' note-books will take much time, especially at first. After every thing has settled into regular working order, it may require six or eight hours more, weekly, of the teacher's time to conduct a class of thirty or forty students in the experimental laboratory course than to conduct a class of the same size in the text-book course, which is to be the alternative.

5th. The fitness of teachers for such work. Probably only a small proportion of the teachers of physics in the preparatory schools have had such a training as would enable them to arrange and conduct the proposed course without considerable effort and some mistakes. For the first year or two crude work is to be expected, but teachers who are possessed of some mechanical skill, a good general knowledge of physics, considerable energy, and a willingness to think, will quickly become accustomed to the duties of the new course.

Just how great the difficulties which have here been touched upon will appear to the preparatory schools the writer is unable to foresee, but there can be little doubt that the larger schools which send boys to Harvard will, in general, speedily adopt the experiment method in preparing boys in physics. Last July about eighty candidates presented themselves for the entrance examination in the experiment course, and, although this course as now laid out will be more severe than that which some schools have followed during the past year, it is unlikely that any school having once undertaken the experiment course will abandon it for the text-book alternative.

The enthusiasm with which many teachers welcome the opportunity to follow the experiment method is very striking, and encourages the hope that the day of perfunctory cramming in physics merely for the purpose of getting into college is nearly over.

E. H. HALL.

Romantic Love and Personal Beauty.

THE above subject in its varied aspects, to which the review of Mr. Finck's book in *Science* has called attention, must be regarded by all thoughtful men, and above all by the biologist, as one of great, possibly unsurpassed interest to mankind. The question in its broadest aspect comes to this: How are the interests of mankind dependent on conjugal mating and the circumstances under which this is brought about? As no one can pretend to see the whole truth on such a subject (or indeed any other of comprehensive range), I shall give the results of my own observations and reflections, with a view of drawing increased attention to a subject of such transcendent importance. While every one, in some vague way, recognizes the importance of the step taken when two human beings agree to join their fortunes for life, the multiform implications of such an act require for their comprehension a biological knowledge that but few, in the present state of civilization, possess.

Mr. Finck, after enumerating the characteristics of romantic love, grants that many of these are found in the lower animals, but at the same time leads us to believe that romantic love is wholly a modern growth, or that it had no genuine existence, at all events, previously. Is this position consistent for an evolutionist? If it existed lower in the scale than man, it seems very unlikely that it should cease to exist in the higher form. Mr. Finck seems to have rather overstated the case. That it never had complete development till modern times, that it was smothered, dwarfed, or perverted, we will freely admit; but we must deny that it is purely a *new* thing. Why is it, as we know it, modern in its development? Because never before was the altruistic conception of human conduct fully developed. That a man should sacrifice himself for an inferior was utterly opposed to all ancient ideas. When this conception took shape it at once began to appear that woman, being the weaker physically at least, demanded, in harmony with the altruistic principle, the service and sacrifice of the stronger, hence gallantry, etc. Formerly this was but an undeveloped germ in the breast of man; but it was there, however, and is not an absolutely new thing. In a word, romantic love demands a relatively high moral development for its vigorous growth. Perhaps Mr. Finck would really contend for no more than this.

Darwin, consistently with the great influence he assigned to sexual selection in his scheme of organic evolution, included man with other animals. He pointed out that "the men who are rich through primogeniture are able to select, generation after generation, the more beautiful and charming women; and these [he adds] must generally be healthy in body and active in mind." No doubt this explains a great deal, but it does not explain the origin of beauty in man or woman. In explaining the high average of comeliness and the relative frequency of beauty in human beings in America, this factor enters very largely into the explanation both of the preservation and increase of beauty of form and expression,

inasmuch as in no part of the world is there such unrestricted conjugal choice. But how does beauty originate? Sometimes suddenly, the offspring being incomparably superior to the parents; more frequently by gradual improvement, though certainly very pronounced in a large proportion of cases. A Darwinian would say this was owing to fortuitous variations and natural selection. But these 'fortuitous' variations Darwin did not attempt to explain. To do this is the task of modern evolutionists. It must be a gradual process so far as details are concerned.

In a paper read at the recent meeting of the American Association, I traced the influence of monotony in the environment, among other causes, in determining race degeneracy in a small and isolated community in the Bahama Islands, and endeavored to place this upon a scientific foundation. In a somewhat elaborate paper just read before the Canada Medical Association, I have advanced a new theory as to nutrition; viz., that the nerve centres are constantly exercising an influence over the nutrition of all the tissues of the body through the nerves distributed to them. This view supplements and explains that maintained in the first paper. It seems to me that it throws an entirely new light on the whole subject of evolution, supplies, in fact, a missing link in the explanation, — at all events for all animals with a nervous system, — and accounts for the origin of variations as, so far as I know, no other theory does. It furnishes what the Lamarckians have lacked but never supplied. I cannot, of course, give in this letter the facts on which this law is founded, but may say that they are of a threefold character: clinical, pathological, and physiological.

The form, etc., of every organ depends upon its mode of growth, upon its nutrition. According to the above theory of a constant neuro-trophic influence, the nutrition is every moment dependent on the nervous system. Now as it is through this system the organism is brought into relation with its environment, so through it the environment is registering its effects every moment. One thing seems to be settled in regard to beauty: it cannot originate when the existence is a purely vegetative one, devoid of all excitement of a psychical kind. That beauty is most frequent among the classes of the community in easiest circumstances, with opportunities for varied excitement of mind (and consequently of body), can thus be understood. That the mental mood causes the face to vary very much in expression is patent to all, and is understood by the influence of the mind over the muscles through nerves by influences radiating from the nerve centres. My theory goes much further than this, however, and assumes a constant influence of the nervous system directing the nutrition of every cell and so the form of the entire organism. By such a view we are able to understand how the young being *in utero* can be moulded to beauty or the reverse, by the environment of the parent. It may be long before we are able to work out the details, but we must not be hopeless even as to that.

This then is a physiological explanation of evolution. Now, although on reflection it must appear that all final explanations of evolution must be physiological, it is remarkable that scarcely a single physiologist has undertaken the solution of any of its problems. I hope to be able in the near future to elaborate the subject from the physiological standpoint and along the lines indicated above. And it is because this explanation seems to bear so directly on vital questions like those treated by Mr. Finck that I write to *Science* on the present occasion.

It is evident that for the best results to mankind there must be the freest choice in conjugal mating. We think biology has now advanced far enough to say of certain persons that they cannot mate without danger of deterioration in the offspring, e.g., in the case of those with a pronounced consumptive or strumous ancestral history; and it says much for the character of those who, with this fear before them, have sacrificed the prospects of conjugal happiness for a time, for the good of the race, by remaining in celibacy. An accomplished, experienced, and wise physician, well educated in the principles of heredity, might often, if consulted, be justified in saying nay. That he could say that any particular union is the best possible, is going far beyond our present biological knowledge.

With the inferior animals we can predict results as to offspring with a certainty that is remarkable. But with man the environment is so much more complex, from his more involved social life, from his high cerebral development (psychical life), that it is impossible to estimate all the factors in the environment; and, if we could, we do not yet know exactly how they act. But nature has not left man without a sure guide. By man's instincts (intuitions) light is supplied, in each instance, that science can as yet give only as general principles. The individual is a light unto himself, provided that he has lived an honest, pure life.

For myself, on this point, I hold the strongest views. My theory as to falling in love would be something to this effect: there are in normal minds the elements of an unformed ideal, which takes definite shape when the person answering to that ideal appears, provided there be no interfering causes. This ideal appertains rather to *type* of individual than to any special person; i.e., there is the potential capacity to love one of many individuals of the type, and the exact individual of this type chosen may be a fortuitous matter. Good results, if not absolutely the best, follow in such cases, no matter which one of the type-class is chosen. As Carlyle said, "No man can love but once, and some not then." The choice of those of opposite tendencies, etc., results in a large proportion of cases in the highest good alike to the individuals themselves, their offspring, and the race. Man and woman in the conjugal state should be the one complementary to the other. The education of the sexes should lead to as much differentiation as possible, in order that the total energy available for the race may be maximal. The education given by parents and the general education of the public should be such as to allow of the highest degree of free, intelligent conjugal choice. If this is accomplished the results as regards beauty will be equally good with those in other directions. I seem, Mr. Editor, to be just getting into the subject, but I fear I have already taken up too much of your space; the importance of such a question must be my excuse.

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The Study of Geography.

THE efforts of the Royal Geographical Society towards the improvement of geographic teaching in England, as recently described in *Science* by Mr. Keltie, deserve particular attention, both from the success already attained and from the need of going still further. The success is conspicuous, if measured only by the recognition and opportunity given to Mr. Mackinder as reader in geography at Oxford; and the advance already gained in the character of models, maps, and illustrations is admirable and enviable; but I cannot help feeling that the shortcomings of the scheme are also apparent. It seems to me that geography itself needs as much attention as the means of teaching and illustrating it: the principles to be taught and the facts to be illustrated need fuller discussion and better choice than they have yet received. But Mr. Keltie, in his recent article in *Science*, says: "Of what is known as physical geography — the topographical surroundings of humanity — there is not much to complain: its facts and principles are pretty well known, and fairly set forth in numerous text-books. It is when we come to apply these facts to humanity, and deal with their bearings on the development of man in communities, that we find so much to desire." I sympathize fully with the second sentence of this quotation, but not at all with the first. Certainly much is still to be done in recognizing and illustrating the bearing of geographic facts on the development of human communities, but quite as much, or more, is yet to be accomplished in the careful study of the facts themselves. Mr. Mackinder, in his address to the Royal Geographical Society (*Proceedings*, March, 1887), includes these geographic facts under 'physiography,' and their relations to humanity under 'physical geography;' but the illustrations that he presents are chiefly of the latter subject, and the tendency of the Society, judging by the character of its Journal of former years and its current Proceedings, is, with small exception, in the same direction. It should be noted, however, that Mr. Mackinder gives much more importance to geologic origin of geographic forms than has been usual. Now it may be true, though I think it is not, that enough is known of physiography to serve the wants of physical geography; but it is undoubtedly true that physiography as a science in itself is in a most immature condition, and is only in recent years obtaining